

DESCRIPTION OF THE PREFERRED EMBODIMENTS

Now, preferred embodiments of the present invention will
5 be described in detail with reference to the annexed drawings.

Fig. 3 is a sectional view illustrating a GaN-based semiconductor LED according to an embodiment of the present invention.

As shown in Fig. 3, the GaN-based semiconductor LED
10 designated by the reference numeral 110 includes a sapphire substrate 111, a first nitride semiconductor layer 113 made of an n type GaN, an active layer 115 having an MQW structure, and a second nitride semiconductor layer 117 made of a p type AlGaIn or p type GaN. An n type electrode 119a is formed on a mesa-
15 etched upper surface of the second nitride semiconductor layer 117. Also, a transparent electrode layer 118 and a p type electrode 119b are sequentially formed on the first nitride semiconductor layer 113.

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The active layer ¹¹⁵~~15~~ having an MQW structure is
20 illustrated as including four undoped GaN barrier layers 115a and five undoped InGaIn quantum well layers 115b alternately laminated over one another. However, there is no limitation on respective materials and numbers of the quantum barrier layers 115a and quantum well layers 115b. For example, the material of

the quantum barrier layers 115b may be appropriately defined by
"Al_{x1}In_{y1}Ga_{1-x1-y1}N (x₁ + y₁ =1, 0 ≤ x₁ ≤ 1, 0 ≤ y₁ ≤ 1). The
quantum well layers 115b are made of a material having an energy
band gap smaller than that of the quantum barrier layers 115b^a.

- 5 The material of the quantum well layers 115b may be
appropriately defined by "Al_{x2}In_{y2}Ga_{1-x2-y2}N (x₂ + y₂ =1, 0 ≤ x₂ ≤ 1,
0 ≤ y₂ ≤ 1).

In the illustrated embodiment, each quantum barrier layer
115a includes an internal layer portion 115a' doped with an n
10 type impurity in order to achieve a reduction in serial
resistance. The internal layer portion 115a' of the quantum
barrier layer 115a has a n type impurity concentration not more
than that of the first nitride semiconductor. Preferably, the
internal layer portion 115a' of the quantum barrier layer 115a
15 has an n type impurity concentration of about 3 x 10¹⁶/cm³ to
about 3 x 10¹⁹/cm³.

In the illustrated embodiment, each quantum barrier layer
115a also includes an anti-diffusion film 115a" arranged at an
interface of the quantum barrier layer 115a with an adjacent one
20 of the quantum well layers 115b. Each of the quantum barrier
layers 115a respectively contacting the first and second nitride
semiconductor layers 113 and 117 may include only one anti-
diffusion film 115a" arranged at an interface of the quantum
barrier layer 115a with the quantum well layer 115b arranged